



Residential Building Energy Efficiency Meeting 2010

Residential Duct Systems for New and Retrofit Homes

Why it is important to properly design and install high quality, efficient ducted air systems ?

- “The efficiency of air distribution systems has been found to be 60-75% or less in many houses because of insufficient and/or poorly installed duct insulation and leaks in the duct system”.
- “Moreover, efficient duct system installations can reduce equipment size, further saving money for new or replacement equipment”.
- Reference: Building Technologies Program. Office of Energy Efficiency and Renewable Energy • U.S. Department Of Energy

Why Is It Important ?

Energy Use, Air Quality, Safety & Comfort

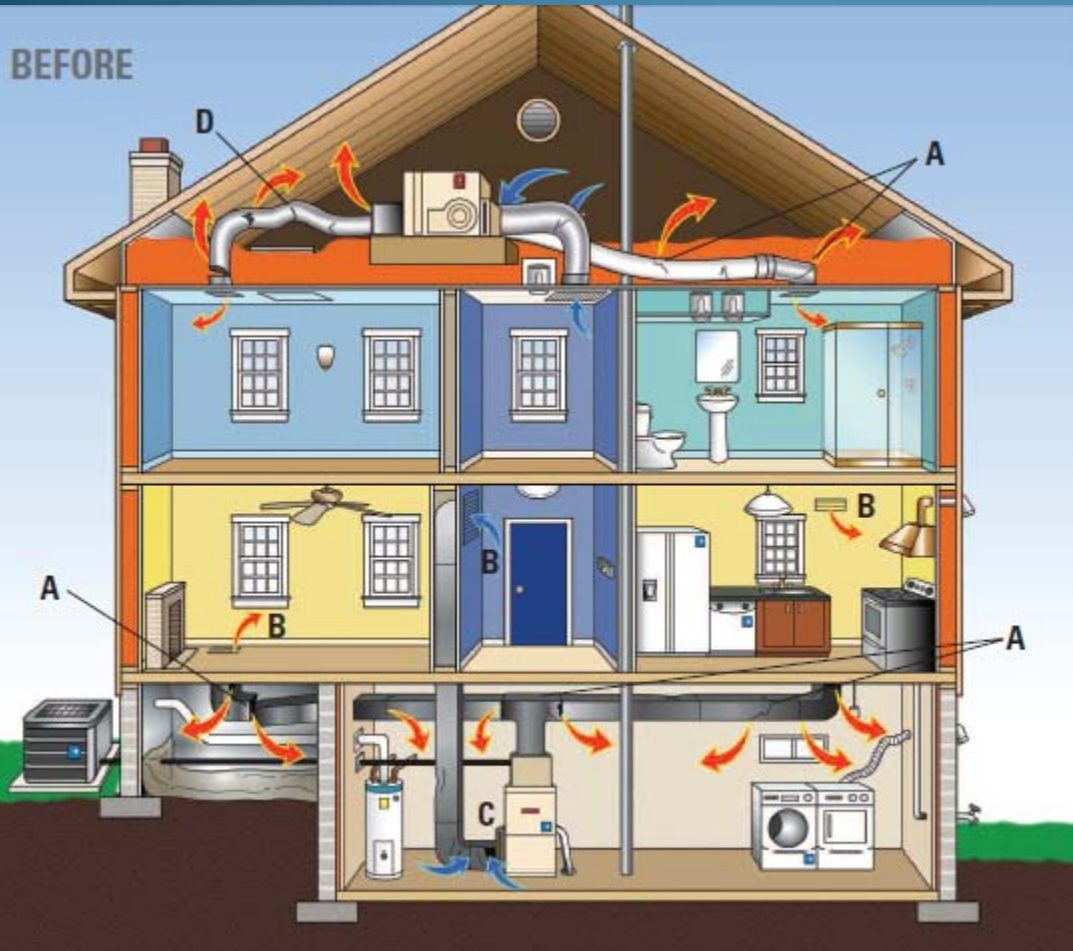
- Poorly designed, installed and unbalanced duct systems may result in conditioned air being forced outside or outdoor air drawn into the house.
- This increases energy consumption and can result in air quality and building pressure problems.

Ductwork Outside The Conditioned Space



Leaky ducts in crawl spaces, attics, unfinished basements, and garages may allow contaminants to enter the home. These ducts may also create pressure imbalances

Available Consumer Information



COMMON DUCT PROBLEMS AND SOLUTIONS

PROBLEMS:

- A. Leaky, torn, and disconnected ducts
- B. Poorly sealed registers and grills
- C. Leaks at furnace and filter slot
- D. Kinks in flexible ductwork restricting airflow

We can add
Insulation concerns

Current Best Practices

New construction or retrofits

- Air distribution system designed using ACCA manual D or other acceptable method
- System design includes proper selection and sizing of grills, registers and diffusers
- Furnace or air handler and all ductwork sealed to be airtight
- Return air systems hard ducted and sealed. Building cavities not used as return ducts.

Current Best Practices

New construction or retrofits

- Duct location: Whenever possible, locate ducts in conditioned spaces. Ducts in unconditioned spaces insulated to a minimum of R-8. or Thermal barrier located to allow furnace or air handler and duct work to be installed within the conditioned space
- Proper air filtration and installation of filter assemblies
- Air distribution system properly installed to maintain mechanical integrity

Current Best Practices

New construction or retrofits

- Air flow testing and balancing (commissioning)
- Conduct a Combustion Safety Test after ducts are sealed to ensure there is no backdrafting of gas or oil-burning appliances
- Energy Star resources for HVAC contractors

[http://www.energystar.gov/index.cfm?c=contractors.
pt_contractors](http://www.energystar.gov/index.cfm?c=contractors_pt_contractors)

ACCA Quality installations

<http://www.acca.org/quality/>

Equipment and Ductwork Sizing for Energy Star[™] Homes

- Based on the Air Conditioning Contractors of America (ACCA) Manual J and D procedures and calculations.
- Manual J: residential load calculation. Software packages available, two common providers are Wrightsoft[®] and Elite software
- Manual D: Residential duct design
- Following the procedures and sizing calculations insures that heating and cooling airflow requirements can be achieved and without excessive energy usage.

Diffuser, Register and Grill Size and Selection

- Supply air diffusers and grill selected per acceptable methods to insure proper air distribution.
- Some applications require careful consideration of diffuser and register performance.
- Challenging applications include, heat pumps, zoned systems and all units with variable air flows.
- Improper selection can lead to comfort and noise complaints.

Duct Sealing

- Existing research quantifies the importance of sealing ducts located in unconditioned spaces
- Furnace or air handler and all ducts should be sealed with mastic or UL 181A or 181B tape.
- An alternative method of duct sealing is available that seals the duct from the inside. The method was developed by the Lawrence Berkley Laboratory and is UL listed and Energy Star® approved
- Recommended reading: ASHRAE Standard 152 & Duct Leaks in Houses
http://www.paltech.com.au/datasheets/Duct_Modera_AS_HRAE_152.pdf

Duct Sealing With Mastic



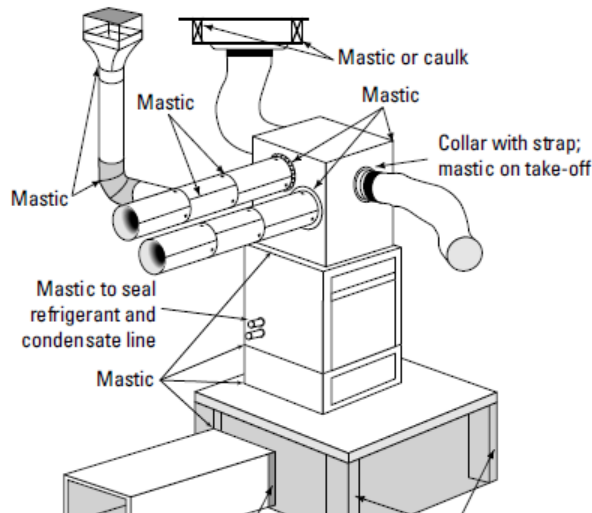


DUCT SEALING

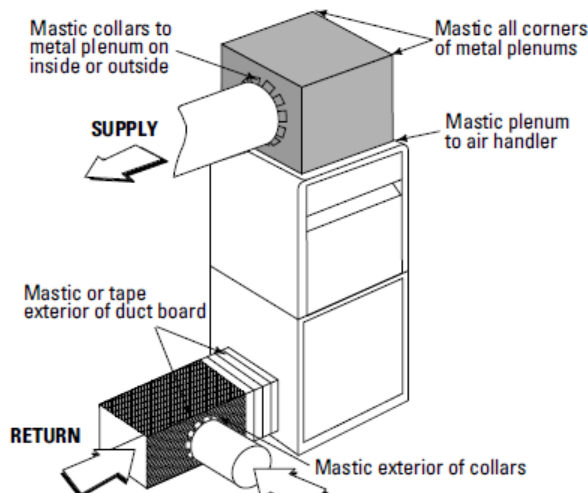


Building Tips

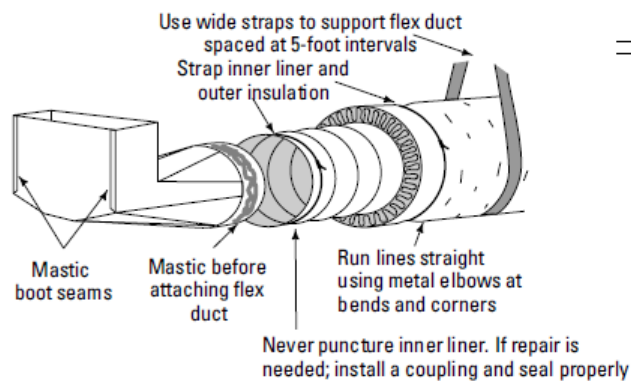
AIR HANDLER



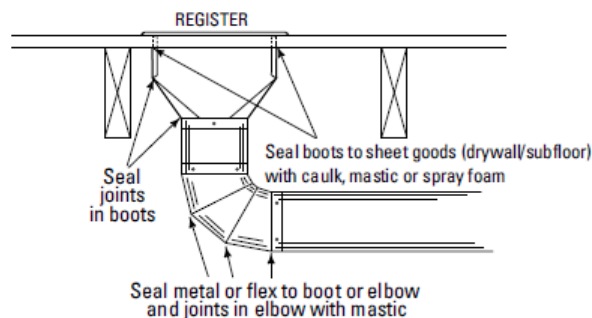
SUPPLY & RETURN PLENUMS



FLEX DUCT



BOOTS



- Mastic is a gooey adhesive that is applied wet. It fills gaps and dries to a soft solid. Mastics may or may not contain reinforcing fibers, and they may be used with reinforcing mesh tape.

Duct Sealing
Information
available
from the
Department
of Energy

Duct Sealing With Aeroseal

- The DOE rated the Aeroseal duct sealing process as one of the 23 most beneficial technologies available to American consumers that has come out since the agency was created.
- UL approved and EPA endorsed
- Aeroseal technique has the advantage of sealing ducts in inaccessible areas
- For more information on this product:
- <http://www.aeroseal.com/researchnews.html>
- <http://www.aceee.org/conf/04et/tt1moder.pdf>

Current Best Practices

Duct Sealing

- The duct systems found in LEED qualified homes, Energy Star rated homes and New homes in California are third-party tested for air tightness and verified to be properly insulated.
- Ducts pressurized to 0.1" water column (25 Pascal's) with a special testing device that can measure the leakage rate. Maximum allowed leakage typically 6% of the design airflow rate
- Testing performed as soon as possible following duct installation

Looking Ahead

- A major code differences in the 2009 International Energy Conservation Code® (IECC) that is not contained in any previous version of the code:
- Mandatory duct pressure testing coupled with maximum allowable duct leakage rates. These requirements are applicable when any portion of the ducts are outside the conditioned space.

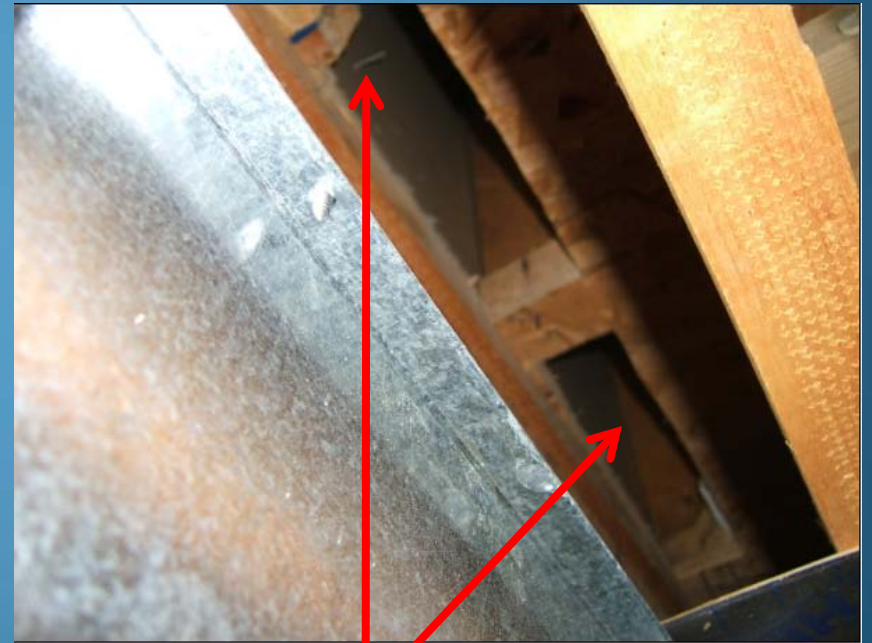
Return Air Systems Hard Ducted And Sealed

- Return air system should be designed and installed with the same concerns as the supply duct system
- In traditional construction the use of building cavities such as floor joist and stud spaces is very common and should be eliminated or cavities should be sealed air tight.
- The use of building cavities for return air can result in air quality problems, higher energy usage and building structure failures.
- Transfer grills or jump ducts should be used to insure return air from all rooms

Building Cavities Used for Return Air



Panning on floor joists

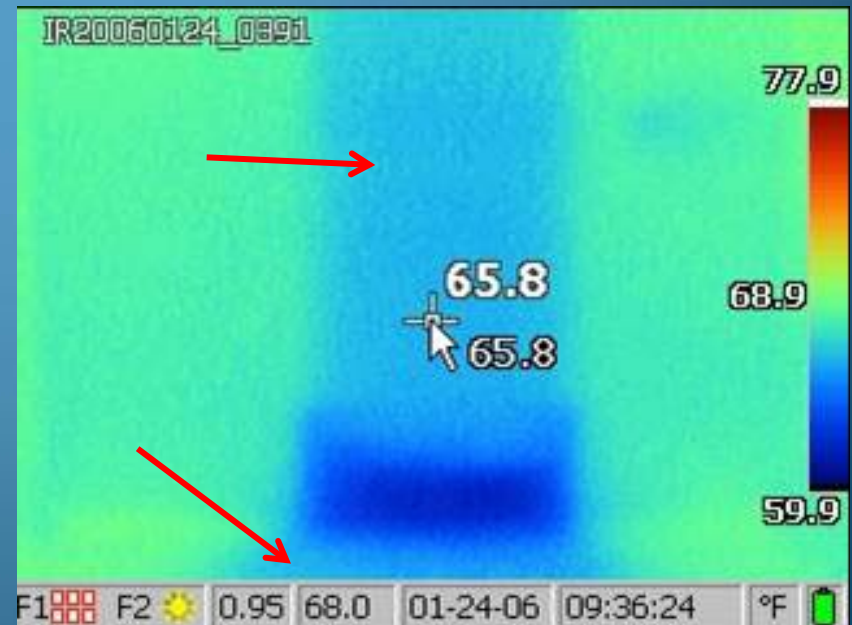


From basement, looking up
into wall cavities

Non Ducted Return Air Problems

Return air grill

Cold air pulling from attic and
band joist



Return Air In Ceiling/Roof Joist Space, Ice Problems & Heat Loss!

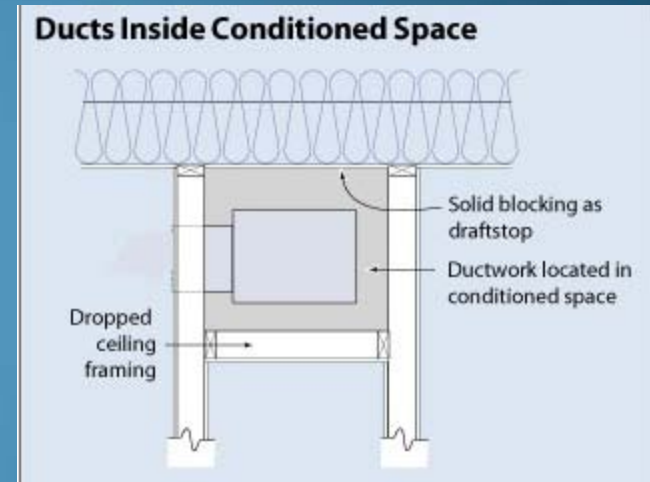
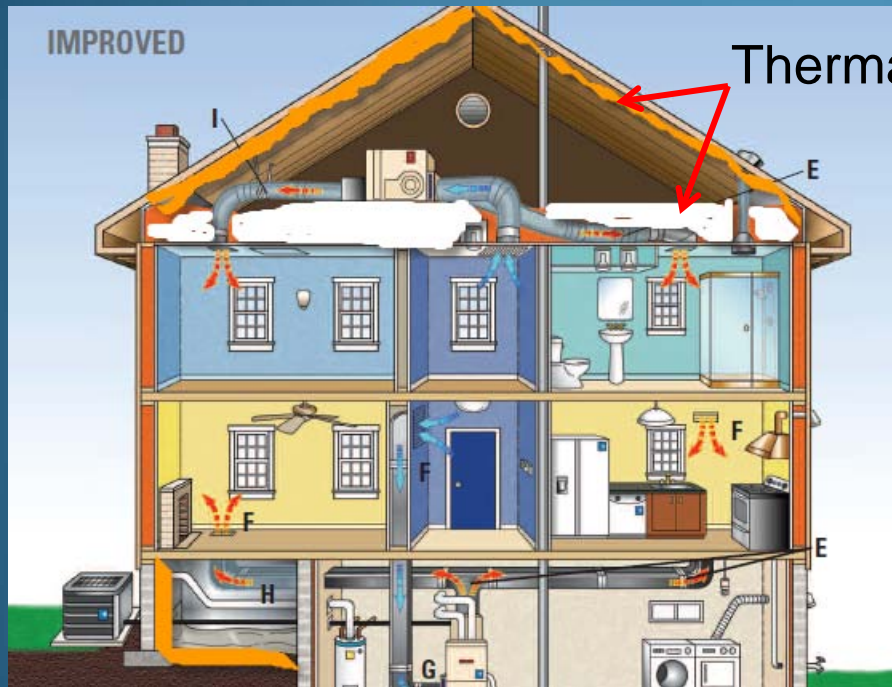


Whenever possible, locate ducts in conditioned spaces



- Avoid wall stacking In exterior wall
- Ducts centrally located in conditioned space eliminate heat loss to the exterior, limit temperature differences at the duct, and allow for shorter duct runs.

HVAC Systems And Ducts In Conditioned Space



- See Research Report - 0111 at building science.com
- ## Placement of Ducts and HVAC Systems in Conditioned Space: An Overview

Ducts in unconditioned spaces insulated to a minimum of R-8

- For ducts located in unconditioned spaces:
- In most areas of the nation, a vapor barrier is required to avoid condensation on the ductwork during cooling operations
- For attic installations, one method of obtaining high insulation values is to bury the duct in attic insulation. Recommended procedures are available for this method.

Challenges

For the non-Energy Star™ or LEED rated Homes and for homes outside of states with improved codes or code enforcement

- Consumer focus on low price
- Difference in incentives between, builder, mechanical contractor, building owner and renters
- Lack of consumer education on benefits of energy efficient installation practices

Challenges

- Highly competitive market
- Consumer knowledge and perceptions
- Lack of mechanical inspections
- Lack of enforcement of existing codes
- Many installations performed without a mechanical permit

Challenges

- High percentage of new installations and equipment replacements are still installed without a proper load calculation, system design or proper start up service.
- Many ductwork systems are sized with “rule of thumb” methods.
- High percentage of installations still have the minimum legal air filtration

Affect of High Efficiency Air Filtration

- The pressure drop associated with high efficiency air filtration must be accounted for in new construction design or retrofits of existing systems.
- The additional pressure drop could result in excessive pressure loss and low airflow or high electrical energy requirements for the fan.

Proper Installation

Michigan mechanical code 605.3

Ducts shall be constructed to allow an even airflow over the entire filter.

90° radius ell w/turning vanes **Inside look at turning vanes**



Common Practice

1" filter with no cover.
No turning vanes in return air 90° ell



Gaps and Barriers

- Difference between duct design sizing (Manual D) and common practice. 6" round duct used for branch ducts because of availability and cost. Should duct design methods adjust to market realities?
- Availability and cost of duct fittings with low friction loss.
- Evaporator coil size. Complicates installations where space is limited.
- Pressure drop of new evaporator coils

Gaps and Barriers

- Education and certification of HVAC designers, installers, and technicians. One of the most critical is the understanding of duct system static pressure and the relationship to performance and energy use
- How to reduce the number of mechanical installations performed without a permit?

Total External Static Pressure

Measuring Supply and Return at the Same Time



Supply static pressure reading, air entering coil

Return static pressure reading, air entering furnace and downstream of the filter

Closing The gaps

- Availability and cost of duct fittings with low friction loss

Better fittings will not be stocked and priced reasonably without a demand. Requires a change in existing common practices

- Evaporator coil size and pressure drops

Research and development of coils for limited space applications and lower pressure drops

Closing The Gaps

Duct sealing

- Code requirements to seal ducts unlikely to result in any real improvement unless third party verification is required. This has already been confirmed see: Washington State Energy Code Study Report at http://www.energy.wsu.edu/documents/code/01_105%20Duct%20rpt%20final.pdf
- Availability and cost of Aeroseal. Franchise costs and overhead limiting use of technology. Increased demand for duct sealing would improve this limitation.

Closing the Gaps

- Promote use of Energy Star Duct Investor or ASHRAE Standard 152, Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Efficiency
- Use this form to submit data to the online version of *ASHRAE Standard 152*.
- http://epb.lbl.gov/ducts/152_ip_form.html
- Should a more practical ,cost- effective method to estimate duct system efficiency be developed and promoted? Goal would be to have something that has wide acceptance and use.

Closing The Gaps

- **Critical:** Enforcement of codes. Large scale change unlikely to occur without code enforcement. Is better code enforcement a realistic expectation or should we set our goals on a different approach?
- HVAC designer, installer and technician certification. We did it for refrigerant use.
- Possible separate licensing for HVACR system engineers. More than one level, residential, light commercial, unlimited

Closing The Gaps

- Development of best practices for register and diffuser selection for variable air flow in residential applications. Practical information for HVAC contractors.